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SUMMARY: Two hundred and fourteen children aged 7-11 years had tests of lung function performed. Mothers were asked about their past and current smoking habits and whether their children had ever had pneumonia or severe bronchitis. The findings suggest a relationship between early childhood bronchitis or pneumonia and impairment of lung function in later childhood and also suggest that maternal smoking habit may contribute directly to impairment of lung function in children.

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RESPIRATORY ILLNESS, MATERNAL SMOKING HABIT AND LUNG FUNCTION IN CHILDREN

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Summary

Two hundred and fourteen children aged 7-11 years had tests of lung function performed. Mothers were asked about their past and current smoking habits and whether their children had ever had pneumonia or severe bronchitis. The findings suggest a relationship between early childhood bronchitis or pneumonia and impairment of lung function in later childhood and also suggest that maternal smoking habit may contribute directly to impairment of lung function in children.

INTRODUCTION

Previous studies (Lunn et al. 1967; Holland et al. 1969) have demonstrated a relationship between bronchitis and pneumonia in early childhood and impairment of lung function in later life. Other work (Colley et al. 1974) has shown that parental smoking can contribute to the development of respiratory illness in early childhood. The present paper explores the influence of these features on subsequent lung function in children.

Methods

In the course of a community study of respiratory function in relation to housing conditions 214 children aged 7-11 years were seen at school. Each child's lung function was measured by the use of a bellows spirometer; heights and weights were recorded. Each child's mother was interviewed at her home.

All lung function measurements were made during the summer months. The following lung function indices were calculated for each child from the spirometer tracings: the forced mid-expiratory flow (FMEF); the forced expiratory volume in 0.75 of a second (FEV_{0.75}); the forced vital capacity (FVC). Statistical methods have been described in detail previously (Yarnell & St Leger 1977) but are summarized briefly below.

The lung function measurements were converted to height-standardized indices by use of the relationship: Derived index = LFT/Height^K, where LFT is the spirometric result for each index of lung function and for each child; the exponent *K* is a constant for each lung function index and for each sex. Values of *K* were calculated from pooled data from this study and are shown in Table 1.

The values of the derived indices have been re-standardized to a height of 130 cm to facilitate comparison of results.

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Table I. Values of exponent K estimated from pooled data

Lung function test	Males	Females
FMF	2.05	2.54
FEV _{0.75}	2.20	2.04
FVC	2.20	1.89

RESULTS

Fig. 1 shows the mean values of the lung function indices standardized to a height of 130 cm, according to the presence or absence of a history of bronchitis or pneumonia in each child. Children with a history of bronchitis or pneumonia have, on average, lower values for the lung function indices FMF and FEV_{0.75} compared to children without such a history. Average FVC values are reduced to a lesser extent. The average reduction in FMF for boys is 9%; and for girls is 12%; the average reduction in FEV_{0.75} for boys is 9%; and for girls is 7%.

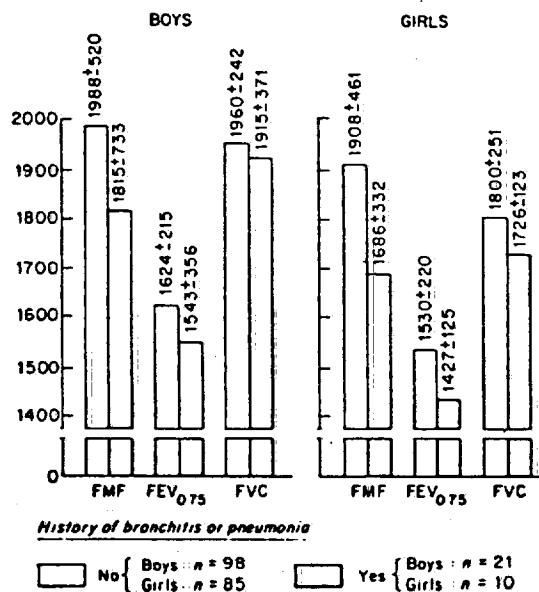


Fig. 1. Lung function and past history of chest infection (mean \pm SD) standardized to height of 130 cm (FMF ml/sec; FEV_{0.75} ml; FVC ml)

Table II shows the distribution of children with and without a history of bronchitis or pneumonia according to the smoking habit of their mothers in pregnancy. Table 2 shows that the offspring of mothers who reported that they had smoked more than 40 cigarettes any time during pregnancy had reduced lung function (FMF and FEV_{0.75}) compared

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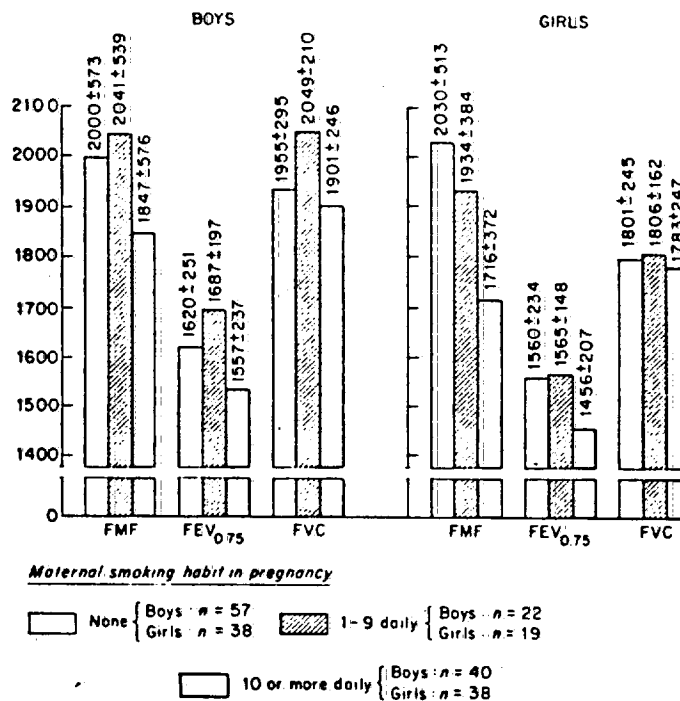


Fig. 2. Lung function and maternal smoking habit in pregnancy (mean \pm SD) standardized to height of 130 cm (FMF ml/sec; FEV_{0.75} ml; FVC ml)

Table II. Numbers of children with history of bronchitis or pneumonia by maternal smoking habit in pregnancy

Maternal smoking habit in pregnancy	Boys		Girls	
	No history	Bronchitis or pneumonia	No history	Bronchitis or pneumonia
None	49	8	34	4
1-9 daily	18	4	15	4
10 or more daily*	31	9	36	2
Total	98	21	85	10

* Very few mothers reported having smoked 20 or more cigarettes daily throughout pregnancy

For the offspring of mothers who had not smoked during pregnancy, the FVC was 2000 ml/sec, and the average reduction in the FVC for male offspring of mothers who smoked 10 cigarettes or more daily is 8%, and for female offspring it is 12%. The corresponding reductions in FEV_{0.75} are 4% for males and 12% for females. In Fig. 3 the relationship between the mother's current smoking habit and the lung

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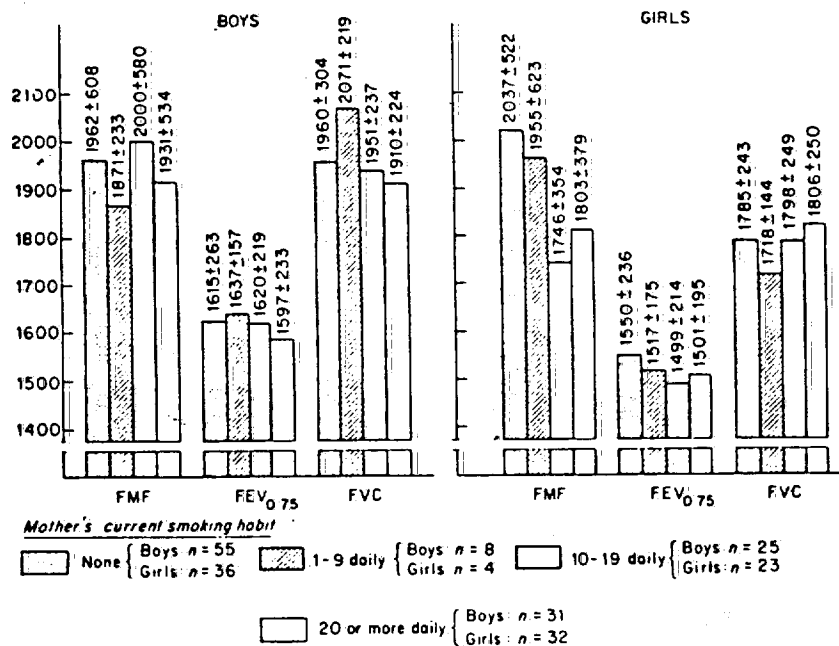


Fig. 3. Lung function and mother's current smoking habit (mean \pm SD) standardized to height of 130 cm (FME ml/sec; FEV_{0.75} ml; FVC ml).

function of their children is examined, no consistent trends are shown. Although a reduction in FME and FEV_{0.75} in the male offspring of mothers who currently smoke 20 or more cigarettes daily is apparent.

Table III shows the children's lung function in relation to the mother's smoking habit during pregnancy and the current household smoking habit (this includes an estimate of the number of cigarettes currently smoked within the home by other household members—usually the father—in addition to the mother's own consumption). This analysis fails to show any further reduction in the lung function of children with increasing household cigarette consumption.

DISCUSSION

The present findings support the evidence for a relationship between early childhood bronchitis or pneumonia and subsequent impairment of lung function in children. Five of the mothers whose children had had bronchitis or pneumonia also said that their child had had asthma at some stage during the child's life. Since the majority of these children had lung function values which were close to the average values for each height group, this subgroup of children did not contribute significantly to the trends shown in Fig. 1.

In the present study, the impairment of lung function of children whose mothers smoked more than 10 cigarettes throughout pregnancy did not appear to be wholly

Table III. Lung function indices (mean, standardized to height of 130 cm) by maternal smoking habit during pregnancy and current household smoking habit (number of subjects shown in parentheses)

Lung function test	Household smoking habit	Boys			Girls		
		Maternal smoking in pregnancy			Maternal smoking in pregnancy		
		None	1-9 daily	10 or more daily	None	1-9 daily	10 or more daily
FMI (ml/sec)	None	1988 (18)			2088 (9)	2409 (1)	
	1-9 daily	1996 (15)	2095 (3)	1934 (2)	1770 (12)	2348 (2)	1346 (1)
	10-19 daily	1951 (17)	2102 (8)	1778 (12)	2264 (12)	1819 (9)	1702 (12)
	20 or more daily	2160 (7)	1983 (11)	1873 (26)	1969 (5)	1894 (7)	1739 (25)
FEV _{0.75} (ml)	None	1557 (18)			1587 (9)	1776 (1)	
	1-9 daily	1682 (15)	1843 (3)	1754 (2)	1472 (12)	1608 (2)	1445 (1)
	10-19 daily	1593 (17)	1637 (8)	1521 (12)	1606 (12)	1521 (9)	1435 (12)
	20 or more daily	1727 (7)	1678 (11)	1557 (26)	1622 (5)	1575 (7)	1466 (25)
FVC (ml)	None	1879 (18)			1781 (9)	2038 (1)	
	1-9 daily	2036 (15)	2344 (3)	2197 (2)	1751 (12)	1712 (2)	1946 (1)
	10-19 daily	1928 (17)	1923 (8)	1901 (12)	1817 (12)	1791 (9)	1734 (12)
	20 or more daily	2027 (7)	2058 (11)	1875 (26)	1916 (5)	1818 (7)	1791 (25)

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caused by an increased tendency to develop bronchitis or pneumonia in early childhood. A slightly greater proportion of boys whose mothers had smoked during pregnancy had a history of bronchitis or pneumonia compared to boys of mothers who had not smoked (Fig. 2), but this tendency is not apparent in girls.

A previous study by Colley et al. (1974) suggested that passive smoking by infants from parental cigarette consumption contributed towards the development of bronchitis or pneumonia in the first year of life. In the present study data on parental smoking habit during each child's first year of life are not available; current paternal smoking habit (recorded in total household smoking habit), however, which is unlikely to have altered substantially throughout the life of the child, does not contribute towards impairment of lung function in a child.

Respiratory morbidity in children varies with the social class of their families (Colley & Reid 1970). Fathers of children in the present study population were predominantly employed in manual and unskilled occupations; the social class of mothers who had smoked and those who had not smoked during pregnancy was therefore similar.

In a previous report on these data we showed that children's lung function differed in three areas of different housing (Yarnell & St Leger 1977). The relative impairment in lung function of children of mothers who smoked 10 or more cigarettes daily during pregnancy reported here is independent of the formerly reported association, however; this tendency is present in all areas of housing in girls and in all areas but one in boys.

In view of the known limitations of certain historical data (Hamman et al. 1975; Lunn et al. 1970), the present findings must be interpreted with some caution. They do suggest, however, that heavy smoking during pregnancy may have a direct effect on the offspring's subsequent lung function which persists at least into late childhood. As noted by Bland et al. (1974) mild impairment of lung function may not be of immediate clinical significance to individual children but may nevertheless indicate a predisposition to chronic bronchitis in adult life. This latent disposition would only be activated by additional factors in adult life; the most important of these is cigarette smoking.

Many studies have reported the long-term effects on the child of maternal smoking during pregnancy (reviewed by Rush & Kass 1972; Butler et al. 1972) but there are few reports of acute effects during pregnancy. Three such reports (Manning et al. 1975; Gennser et al. 1975; Manning & Feyerabend 1976) note that fetal breathing movements are inhibited by maternal cigarette smoking. If the findings of the present study are confirmed these reports may explain at least part of the impairment of lung function in children of mothers who smoked heavily during pregnancy of a mechanism which operates *in utero*.

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Tabulated details of the results of this study may be obtained directly from the authors.

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